HOLTEC INTERNATIONAL

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November 18, 2013

John Goshen, P.E., Project Manager – Licensing Branch
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety and Safeguards

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Docket No. 72-1040
Certificate of Compliance (CoC) No. 1040

Subject: Thermal verification of "UMAX" by testing

Reference: [1] NRC Staff Evaluation of Holtec's Responses to Request for Additional Information Letter for HI-STORM UMAX Cask System (Letter from J. Goshen (NRC) to Stefan Anton (Holtec), dated October 21, 2013) (TAC NO. L24664)
[2] Presentation "On the Staff's Proposal to Empirically Derate the Conservatively Computed Heat Load for HI-STORM UMAX" by Dr. Kris Singh on November 15, 2013

Dear Mr. Goshen:

Thank you for organizing the public meeting on November 15, 2013 and for giving us the opportunity to share our thoughts with the staff and SFST management on the path forward on the subject of thermal testing of the "UMAX" VVMs. The meeting helped illuminate several salient points that should be helpful in the drafting of NRC's SER, such as:

1. The thermal input parameters used to determine the *Design Basis Heat Load (DBHL)* (such as the most adverse wind velocity and direction) are the most severe of any ventilated system certified in the past. The added conservatisms introduced in the thermal modelling of "UMAX" and thus unique to it are estimated to reduce the DBHL by over 3 kW.

2. The DBHL set down for "UMAX" is lower than that for "FW", even though the former has a larger annular flow area around the MPC.

3. From the standpoint of fluid flow regime and physical anatomy, "UMAX" is identical to the previously certified "100U" and very similar to hundreds of above-ground HI-STORMs deployed across the country.

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4. The veracity of FLUENT, established by benchmarks by Holtec, NRC and hundreds of other organizations places this code in the same class as other widely used codes such as ANSYS & LS-DYNA, which serve as the trusted vehicles for critical safety analyses in dry storage FSARs. Thanks to our long interactions with the NRC research and other international regulators over the past two decades on the modelling of FLUENT, the fidelity of our analysis model for "UMAX", we believe, meets with NRC's expectations in full measure.

5. The higher DBHL for "UMAX" compared to the MPCs in HI-STORM 100 is entirely due to the fact that the former's basket material (Metamic HT) is over 10 times as conductive as the latter's stainless steel basket material, and the "UMAX" also has larger (optimized) flow passages (to reduce hydraulic losses).

6. The air flow tests performed on loaded HI-STORMs in the past, going back well over a decade, have consistently demonstrated that the FLUENT model employed by Holtec is conservative. Appendix A (Enclosure 1) to this letter contains tables of prior thermal tests and the inferred margins from them.

7. Because of 37 storage locations, the average heat load allotted to each assembly is merely 1.25 kW (for PWR fuel), which requires that a regionalized storage scheme be used to place "hot" fuel in storage. The fuel storage plan for any plant must take full advantage of regionalization from the very beginning if it is to avoid the specter of partial loading and other ALARA-adverse measures in the future. The DBHL in the range of 46 kW, therefore, is an essential part of a loading dose minimization strategy.

The above thoughts are further elaborated in the PowerPoint presentation of November 15, 2013 entitled "On the Staff's Proposal to Empirically Derate the Conservatively Computed Heat Load for HI-STORM UMAX" by Dr. Kris Singh [2].

The above said, Holtec concurs with the Staff that the thermal verification tests should be conducted with greater technical rigor than has been the case in the past. Holtec also agrees that characterizing the thermal test as a condition of the Certificate of Compliance (CoC) is inappropriate. Rather, the test should be stated in the FSAR as a safety compliance requirement (similar to other vital requirements such as 100% radiography of MPC butt welds, temperature limit during vacuum drying, etc.) imposed on the system. Towards this end, we have re-written subsection 10.3(iii) of the FSAR which deals with thermal testing. The revised text, included in Appendix B (Enclosure 2) herein, provides a comprehensive set of requirements and procedural guidelines for thermal testing of "UMAX" modules. Holtec has also removed Condition 8 to the CoC; the updated draft is provided as Appendix C (Enclosure 3) to this letter.

Holtec trusts the proposed verbiage in Appendix B will help us move forward on this application. We thank you and the Staff for having completed the SER on all other sections. Our client, Ameren, and our company are reassured by the management attention being given to our time-critical "UMAX" application for which we thank you again.

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If you have any questions, then please contact me at (856)-797-0900 ext. 3569.

Sincerely,

Dr. Stefan Anton
VP of Engineering,
Acting Licensing Manager,
Holtec International

cc: (letter only w/o Attachments)
Mark Lombard
Michele Sampson
Christian Araguas
Jorge Solis
Ghani Zigh
John Goshen
Kris P. Singh
Mark Beaumont
Debu Majumdar
HUG Licensing Subcommittee
Holtec Marlton
David Shafer (Ameren)
Elizabeth Ptasznik (Ameren)

Enclosures:

Enclosure 1: Appendix A, Thermal Validation Tests Data (Holtec Proprietary Information) (3 pages)
Enclosure 2: Appendix B, Marked-up Proposed FSAR changes of Section 10.3(iii), Proposed Revision 1B (5 pages)
Enclosure 3: Appendix C Marked-up Proposed CoC changes (5 pages)

Appendix B to Holtec Letter 5021015:

Marked-up Proposed FSAR changes of Section 10.3(iii), Proposed Revision 1B

10.3 INSPECTIONS AND TESTING

i. Post-Construction Inspection:

Each as-built HI-STORM UMAX VVM shall be inspected for final acceptance before it is loaded with fuel. The following inspections define minimum acceptance requirements:

a. The as-installed CEC shall be inspected to ensure that it will not hinder installation of the Closure Lid.

b. The CEC Flange Shell gasket/seal bearing surfaces shall be inspected for its horizontal alignment (within specified tolerance). The seals shall be inspected for general condition (lack of cuts, tears, or degradation that could lead to poor sealing).

c. The Closure Lid skirt shall be checked for fit-up with the CEC Flange.

d. The outlet air passage in the Closure Lid shall be inspected for absence of obstruction such as debris and extensive weld spatter.

e. The results of the post-construction inspection shall be incorporated in the VVM's Documentation Package.

f. The impressed current cathodic protection system (ICCPS), if used, shall be tested for operability using Holtec provided procedures.

ii. Shielding Integrity and Effectiveness Test:

Operational neutron and gamma shielding effectiveness tests shall be performed after the first fuel loading at the host plant site using written and approved procedures. Calibrated neutron and gamma dose rate meters shall be used to measure the actual neutron and gamma dose rates at the accessible surface of the HI-STORM UMAX VVM. Measurements shall be taken at the locations specified in the Radiation Protection Program for comparison against the prescribed limits. The test is performed to identify the expected dose levels around the VVM in order to plan for appropriate radiation protection measures for future cask loadings. Dose rate measurements shall be documented and shall become part of the quality record of the loaded cask.

iii. Thermal Acceptance Test

The *Design Basis Heat Load (DBHL)*~~thermal performance~~ of the HI-STORM UMAX system is ~~demonstrated~~ *established by using a three dimensional computational fluid dynamics model implemented on computer code FLUENT* ~~through analysis~~ in Chapter 4 of this FSAR.

A thermal test program to verify the conservatism in the DBHL of the "UMAX" system shall be implemented by the certificate holder. This test program is intended to serve as the supplemental means to verify the safety analysis documented in Chapter 4. The essential features of the test program and applicable requirements are provided below:

a. The test shall be performed using a QA validated written procedure.
b. The test shall be carried out on the first loaded system whose aggregate heat load exceeds 50% of the DBHL.
c. Any subsequently loaded system whose aggregate heat load exceeds the preceding tested system by 10% of the DBHL will be tested. The tested systems are referred to as the "Thermal Performance Adequacy Calibrators" (TPACs).
d. A system loaded at a lower aggregate heat load than a previously tested TPAC does not need to be tested.
e. The test will be carried out on each TPAC in as stored condition after a hiatus of at least three days to permit the system to reach a condition of quasi-steady state.
f. The test shall consist of measuring the air flow velocity in the outlet duct and air temperature in all four inlet ducts and the outlet duct for a period of at least three days ("Test Period"). Multiple flow and temperature indicators, calibrated under the ISFSI owner's or Holtec's QA program shall be employed to insure that mass flow rate in outlet duct is aggregated for the cross section from local velocity measurements. Measurement of the wind, insolation and humidity in the ambient air during the Test Period shall also be recorded.
g. Averaged values of the measured parameters necessary to fully define the input to the FLUENT model shall be used to predict the system performance. The actual mass flow through the system using the measured air flow, temperature, humidity and wind data is expected to exceed the predicted mass flow from the FLUENT model.
h. Pursuant to 10CFR72.4, a letter report summarizing the results of the thermal validation test and analysis shall be submitted to the NRC and the Holtec User Group (HUG) within 90 days after completion of the test. If the test results corroborate the design basis FLUENT model then no further action is necessary. However, if the test results indicate a deficit in the system's thermal performance ,then the following actions are necessary:
    - *The discrepancy shall be entered in the certificate holder's Corrective Action Program (CAR) pursuant to which a root cause evaluation shall be performed.*
    - *Unless the root cause evaluation identifies supervening reason(s) other than an intrinsic deficit in the system's thermal performance, the DBHL of the system shall be reduced to 95% of the value indicated by the FLUENT model re-calibrated by the test data. All "UMAX" users and the NRC shall be so informed within 7 days.*

- *The next loaded cask shall be designated as a TPAC and tested to serve as an input in the CAR process.*
- *The DBHL shall not be restored to the as-certified value until three consecutive tests on three TPACs, each with a higher aggregate heat load than the discrepant system, demonstrate the conservatism in the FLUENT model.*
- *The NRC and HUG shall be kept abreast of the evolution of the CAR process.*

i. *A Documentation package of the test including all relevant equipment calibration records, acquired data ,analyses and results shall be compiled and saved as Permanent record in Holtec's Configuration Control System as required by the certificate holder's QA program.*

The responsibility to report and to ensure that the test is conducted under an approved QA program lies with the certificate holder. The ISFSI owner has the collateral responsibility to provide all necessary resources including calibrated instruments, RP personnel, tools, test personnel and facilities to support the testing effort. The ISFSI owner must review and concur with the procedure to implement the test which will be prepared by the certificate holder.

~~However, a thermal acceptance test shall be performed on the first fully loaded VVM assembly whose aggregate MPC heat load is at least 50% of the Design Basis maximum heat load per the system CoC. (Because of its in-ground installation, a thermal test at a lower heat load is apt to be too inaccurate to provide meaningful information.)~~

~~After the system has been in storage for at least one week (to reach steady state) and when the ambient is relatively quiescent and the solar heat deposition rate is minimal, the surface temperature of the top of the MPC lid shall be measured at the center and 4 orthogonally disposed peripheral locations.~~

~~The measured lid temperature data (at designated measurement points) shall be compared with the results predicted by the FLUENT analysis.~~

~~The measured temperatures (in Deg. F) must be no greater than 5% over the corresponding analytically predicted temperatures to be acceptable. Otherwise, the Design Basis heat load capacity of the VVM assembly will be downgraded by incorporating a penalty factor in the FLUENT model and the USNRC so informed. The reduced heat load values will become the *de facto* limits for all VVMs at the site until a root cause evaluation indicates extenuating circumstances unique to the site.~~

~~The heat load anomaly must be resolved by additional testing: until then, the reduced heat load limit will apply to all HI STORM UMAX sites.~~

~~The technical specifications require~~*In addition to the above performance a continuous validation program consisting of* periodic surveillance of the system air inlet and outlet vents or implementation of a HI-STORM UMAX VVM air temperature monitoring program to provide ongoing assurance of the operability of the HI-STORM UMAX heat removal system~~.~~ *shall be maintained as spelled out in the Technical Specification.*

iv. Storm Water Control Test

The HI-STORM UMAX VVM is designed to direct storm water and snow/ice melt-off away from the CEC Flange and the Closure Lid where the air passages are located. The engineered rain caps installed on the inlet and outlet serve to keep rain and snow away from the VVM cavity. Moreover, any minor amount of moisture that may intrude into the MPC cavity due to wind-driven rain will evaporate in a short period of time due to the continuous movement of heated air in the MPC storage cavity. To verify the effectiveness of the storm water drainage design, a one-time test shall be performed after construction of the first VVM to ensure that the design is effective in directing storm water away from the VVM to the ISFSI's drainage system. The VVM shall be subjected to a water spray that simulates exposure to rainfall of at least 2 inches per hour for at least one hour. At the conclusion of the water spray, the depth of the water (if any) in the bottom of the module cavity shall be measured. Any amount of water accumulation beyond wetting of the Bottom Plate indicates an inadequacy in rain diversion features of the VVM and shall be appropriately corrected. It should be noted that accumulation of water is not injurious to the thermal performance of the system. The only deleterious effect of prolonged exposure to water is the potential for reducing the service life of the preservative on the wetted surface of the Bottom Plate, CEC shell, and other interfacing components.

Appendix C to Holtec Letter 5021015:

Marked-up Proposed CoC Changes

NRC FORM 651
(10-2004)
10 CFR 72

CERTIFICATE OF COMPLIANCE
FOR SPENT FUEL STORAGE CASKS

U.S. NUCLEAR REGULATORY COMMISSION

The U.S. Nuclear Regulatory Commission is issuing this Certificate of Compliance pursuant to Title 10 of the Code of Federal Regulations, Part 72, "Licensing Requirements for Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste" (10 CFR Part 72). This certificate is issued in accordance with 10 CFR 72.238, certifying that the storage design and contents described below meet the applicable safety standards set forth in 10 CFR Part 72, Subpart L, and on the basis of the Final Safety Analysis Report (FSAR) of the cask design. This certificate is conditional upon fulfilling the requirements of 10 CFR Part 72, as applicable, and the conditions specified below.

Certificate No.	Effective Date	Expiration Date	Docket No.	Amendment No.	Amendment Effective Date	Package Identification No.
1040	TBD	TBD	72-1040	0		USA/72-1040

Issued To: (Name/Address)

Holtec International
Holtec Center
555 Lincoln Drive West
Marlton, NJ 08053

Safety Analysis Report Title

Holtec International
Final Safety Analysis Report for the
HI-STORM UMAX Canister Storage System

This certificate is conditioned upon fulfilling the requirements of 10 CFR Part 72, as applicable, the attached Appendix A (Technical Specifications) and Appendix B (Approved Contents and Design Features), and the conditions specified below:

APPROVED SPENT FUEL STORAGE CASK

Model No.: HI-STORM UMAX Canister Storage System

DESCRIPTION:

The HI-STORM UMAX Canister Storage System consists of the following components: (1) interchangeable multi-purpose canisters (MPCs), which contain the fuel; (2) underground Vertical Ventilated Modules (VVMs), which contains the MPCs during storage; and (3) a transfer cask (HI-TRAC VW), which contains the MPC during loading, unloading and transfer operations. The MPC stores up to 37 pressurized water reactor fuel assemblies or up to 89 boiling water reactor fuel assemblies.

The HI-STORM UMAX Canister Storage System is certified as described in the" UMAX" Final Safety Analysis Report (FSAR) supplemented by the information on the MPCs and transfer cask in the HI-STORM FW FSAR, and in the U. S. Nuclear Regulatory Commission's (NRC) Safety Evaluation Report (SER) accompanying the Certificate of Compliance (CoC).

The MPC is the confinement system for the stored fuel. It is a welded, cylindrical canister with a honeycombed fuel basket, a baseplate, a lid, a closure ring, and the canister shell. All MPC components that may come into contact with spent fuel pool water or the ambient environment are made entirely of stainless steel or passivated aluminum/aluminum alloys. The canister shell, baseplate, lid, vent and drain port cover plates, and closure ring are the main confinement boundary components. All confinement boundary components are made entirely of stainless steel. The honeycombed basket provides criticality control.

DESCRIPTION (continued)

There are two types of MPCs permitted for storage in HI-STORM UMAX VVM: the MPC-37 and MPC-89. The number suffix indicates the maximum number of fuel assemblies permitted to be loaded in the MPC. Both MPC models have the same external diameter.

The HI-TRAC VW transfer cask provides shielding and structural protection of the MPC during loading, unloading, and movement of the MPC from the cask loading area to the VVM. The transfer cask is a multi-walled (carbon steel/lead/carbon steel) cylindrical vessel with a neutron shield jacket attached to the exterior and a retractable bottom lid used during transfer operations.

The HI-STORM UMAX VVM utilizes a storage design identified as an air-cooled vault or caisson. The HI-STORM UMAX VVM relies on vertical ventilation instead of conduction through the fill material around the VVM, as it is essentially a below-grade storage cavity. Air inlets and an air outlet allow air to circulate naturally through the cavity to cool the MPC inside. The subterranean steel structure is seal welded to prevent ingress of any groundwater in the MPC storage cavity from the surrounding subgrade, and it is mounted on a stiff foundation. The surrounding subgrade and a top surface pad provide significant radiation shielding. A loaded MPC is stored within the HI-STORM UMAX VVM in a vertical orientation.

CONDITIONS

1. OPERATING PROCEDURES

   Written operating procedures shall be prepared for handling, loading, movement, surveillance, and maintenance. The user's site-specific written operating procedures shall be consistent with the technical basis described in Chapter 9 of the FSAR.

2. ACCEPTANCE TESTS AND MAINTENANCE PROGRAM

   Written acceptance tests and a maintenance program shall be prepared consistent with the technical basis described in Chapter 10 of the FSAR. At completion of welding the MPC shell to baseplate, an MPC confinement weld helium leak test shall be performed using a helium mass spectrometer. This test shall include the base metals of the MPC shell and baseplate. A helium leakage test shall also be performed on the base metal of the fabricated MPC lid. The confinement boundary welds leakage rate test shall be performed in accordance with ANSI N14.5 to "leaktight" criterion. If a leakage rate exceeding the acceptance criteria is detected, then the area of leakage shall be determined and the area repaired per ASME Code Section III, Subsection NB, Article NB-4450 requirements. Re-testing shall be performed until the leakage rate acceptance criterion is met.

   To verify the effectiveness of the storm water drainage design, a one-time test will be performed after construction of the first VVM at the first site to deploy UMAX to ensure that the design is effective in directing storm water away from the VVM to the ISFSI's drainage system. The VVM will be subjected to a water spray that simulates exposure to rainfall of at least 2 inches per hour for at least one hour. At the conclusion of the water spray, the depth of the water (if any) in the bottom of the module cavity will be measured. Any amount of water accumulation beyond wetting of the Bottom Plate indicates an inadequacy in rain diversion features of the VVM and will be appropriately corrected.

3. QUALITY ASSURANCE

   Activities in the areas of design, purchase, fabrication, assembly, inspection, testing, operation, maintenance, repair, modification of structures, systems and components, and decommissioning that are important-to-safety shall be conducted in accordance with a Commission-approved quality assurance program which satisfies the applicable requirements of 10 CFR Part 72, Subpart G, and which is established, maintained, and executed with regard to the storage system

4. HEAVY LOADS REQUIREMENTS

Each lift of an MPC or a HI-TRAC VW transfer cask must be made in accordance to the existing heavy loads requirements and procedures of the licensed facility at which the lift is made. A plant-specific review of the heavy load handling procedures (under 10 CFR 50.59 or 10 CFR 72.48, as applicable) is required to show operational compliance with existing plant specific heavy loads requirements. Lifting operations outside of structures governed by 10 CFR Part 50 must be in accordance with Section 5.2 of Appendix A.

5. APPROVED CONTENTS

Contents of the HI-STORM UMAX Canister Storage System must meet the fuel specifications given in Appendix B to this certificate.

6. DESIGN FEATURES

Features or characteristics for the site or system must be in accordance with Appendix B to this certificate.

7. CHANGES TO THE CERTIFICATE OF COMPLIANCE

The holder of this certificate who desires to make changes to the certificate, which includes Appendix A (Technical Specifications) and Appendix B (Approved Contents and Design Features), shall submit an application for amendment of the certificate.

~~8. SPECIAL REQUIREMENTS FOR FIRST SYSTEMS IN PLACE~~

~~A thermal acceptance test shall be performed in accordance with Section 10.3 of the HI-STORM UMAX FSAR on the first loaded MPC whose aggregate heat load is greater than or equal to 50% of the Design Basis MPC heat load .The measured thermal performance of the storage system shall be used to benchmark the computational fluid mechanics model used in the safety analysis in chapter 4 of the HI-STORM UMAX FSAR.~~

~~A letter report summarizing the results of the thermal validation test and analysis shall be submitted to the NRC in accordance with 10 CFR 72.4. Cask users may satisfy this requirement by referencing a validation test report submitted to the NRC by another cask user.~~

~~9.~~ *8.* PRE-OPERATIONAL TESTING AND TRAINING EXERCISE

A dry run training exercise of the loading, closure, handling, unloading, and transfer of the HI-STORM UMAX Canister Storage System shall be conducted by the licensee prior to the first use of the system to load spent fuel assemblies. The training exercise shall not be conducted with spent fuel in the MPC. The dry run may be performed in an alternate step sequence from the actual procedures, but all steps must be performed. The dry run shall include, but is not limited to the following:

a. Moving the MPC and the transfer cask into the spent fuel pool or cask loading pool.

b. Preparation of the HI-STORM UMAX Canister Storage System for fuel loading.

c. Selection and verification of specific fuel assemblies to ensure type conformance.

d. Loading specific assemblies and placing assemblies into the MPC (using a dummy fuel assembly), including appropriate independent verification.

e. Remote installation of the MPC lid and removal of the MPC and transfer cask from the spent fuel pool or cask loading pool.

f. MPC welding, NDE inspections, pressure testing, draining, moisture removal (by vacuum drying or forced helium dehydration, as applicable), and helium backfilling. (A mockup may be used for this dry-run exercise.)

g. Transfer of the MPC from the transfer cask to the VVM.

h. HI-STORM UMAX Canister Storage System unloading, including flooding MPC cavity and removing MPC lid welds. (A mockup may be used for this dry-run exercise.)

Any of the above steps can be omitted if the site has already successfully loaded a Holtec MPC System.

~~10.~~9. AUTHORIZATION

The HI-STORM UMAX Canister Storage System, which is authorized by this certificate, is hereby approved for general use by holders of 10 CFR Part 50 licenses for nuclear reactors at reactor sites under the general license issued pursuant to 10 CFR 72.210, subject to the conditions specified by 10 CFR 72.212, this certificate, and the attached Appendices A and B. The HI-STORM UMAX Canister Storage System may be fabricated and used in accordance with any approved amendment to CoC No. 1040 listed in 10 CFR 72.214. Each of the licensed HI-STORM UMAX Canister Storage System components (i.e., the MPC, overpack, and transfer cask), if fabricated in accordance with any of the approved CoC Amendments, may be used with one another provided an assessment is performed by the CoC holder that demonstrates design compatibility. .

FOR THE U. S. NUCLEAR REGULATORY COMMISSION

/RA/

TBD
Licensing Branch
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety
and Safeguards
Washington, DC 20555

Dated TBD

Attachments:
1. Appendix A
2. Appendix B